Conference Summary
The Sixth Annual General James H. Doolittle Conference

Unmanned Aerial Vehicles: Their Value in Security Operations

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Unmanned Aerial Vehicles: Their Value in Security Operations

The summary of The Sixth Annual James H. Doolittle Conference, sponsored by the MIT Security Studies Program.
April 21, 1999
MIT Faculty Club
Cambridge, MA

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The conference was organized by Colonel Leonard Samborowski, the 1998-1999 U.S. Army Fellow at the MIT Security Studies Program. Administrative and Editorial Assistance was provided by Kristen Cashin.

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INTRODUCTION

The "Value of Unmanned Aerial Vehicles in Security Operations" was the focus of the Sixth Annual James H. Doolittle Conference, held on 21 April 1999 at the MIT Faculty Club in Cambridge, Massachusetts. General Doolittle, an aviation pioneer and military hero, received his PhD from MIT in 1925. Since 1993, the Security Studies Program has honored the innovative spirit of Jimmy Doolittle by hosting a symposium on airpower issues. In attendance at this year's conference were representatives from the military, academia, government and industry.

The morning panel focused on the *Operational Uses of Unmanned Aerial Vehicles* (UAVs). The luncheon speaker was Colonel William Knarr who spoke on the Army's requirements for UAVs and the process for fielding the systems. The afternoon panel highlighted the *Development of Service Operational Requirements for Unmanned Aerial Vehicles.* At dinner, LTG Campbell offered anecdotal insights that could be applied to the UAV procurement process.

At the conference, the value of UAVs to security operations was thoroughly briefed and discussed by a wide range of subject matter experts from the government, military, industry and academia.

Conference attendees concluded that technology is not the main obstacle to develop and fielding tactical UAVs. Rather, conflicting organizational requirements, interservice conflicts and intraservice competition seem to be the primary barriers to the smooth integration of UAVs into the present day war fighting force.

The problems mentioned above must be resolved because the continued use of UAVs by the military is inevitable. Reduced military funding, in combination with integrated "machines" directed by powerful microprocessors, electro-optic, radio frequency, power and propulsion technology advances and American discomfort with casualties all will lead to the increased use of drones.

UAVs are a booming stock commodity that will continue to provide big returns on their investments for the next half-century. As America approaches the 100 year anniversary of the airplane (17 December 1903, Kitty Hawk, North Carolina) it can be said that the modern day competitor for future Orville Wrights is a 200 pound flying wing, attached to a GPS and radio antenna. Throw away the silk scarves and break out the duct tape, the UAV has arrived.

As of 1998:

- 14 Countries have some type of unmanned aerial vehicle in service

- 15 Nations are on contract for additional UAV systems
- 13 Governments have submitted Requests for Proposals for UAVs
- 12 Defense Departments are involved in some type of UAV product evaluation

UAV production is a growth industry. As shown in the chart below, since 1993 the number of different global unmanned aerial vehicles has increased by 102%, while the number of product suppliers for engines and recovery systems has grown by 329% and 336% respectively.

	1993	**1998**
# of Unmanned Air Vehicles	50	101
# of Suppliers for Unmanned Vehicles (All Types)	151	470
# of Suppliers for Unmanned Vehicles, by Product (Engines)	14	60
# of Suppliers for Unmanned Vehicles, by Product (Launchers and Recovery Systems)	11	48
# of Suppliers for Unmanned Vehicles, by Product (Platforms)	74	173

Information taken from *1993 Unmanned Vehicles Handbook* (London: Shepherd Press, 1993) and *1998 Unmanned Vehicles Handbook* (London: Shepherd Press, 1998)

Country surveillance, refugee monitoring, communication relay, electronic jamming, search and rescue operations, environmental work, suppression of enemy air defenses, combat escort and reconnaissance, laser target designation and land mine detection are some of the future uses of Unmanned Aerial Vehicles. However, the acceptance of these new roles and missions for unmanned aircraft will require a demonstration of cost savings and operational advantages before implementation. The manned aircraft community will not go peacefully into the night as they recognize they are being replaced by R2D2.

The only foreseeable obstacle in an otherwise rosy future for UAVs is the unnecessary complication of a straightforward plan. Potentially promising UAV programs of the past (Aquila, Hunter, DarkStar) suffered from a perceived need to make a simple platform better than it needed to be. This can't continue. The insatiable human need for the latest and greatest technology is an appetite that must be curbed in regards to UAV procurement.

The challenge is to delink the development of near future (2000-2015) UAVs from longer term concepts like the Army After Next, the Digitized Battlefield and Air Force Global Reach. To make it work the military should:

- Develop UAV design criteria tailored to the user's operational needs vice wants. This means deciding on a set of prioritized essential system requirements. Don't ask for a Swiss Army knife when you only need to spread the butter.
- Keep it simple during each step of the acquisition process. Prototype a UAV in its simplest form.
- Put the plain prototype into the hands of military users to ensure system suitability.
- Ensure that the prototype is what the user NEEDS, then field and test the UAV as early as possible. Expansion of basic capabilities will only be allowed after fielding and testing.
- Immediately incorporate the UAV into National Training Center (NTC) and Joint Readiness Training Center (JRTC) rotations. Early exposure to military exercises will develop advocacy that will help support the early growing pains of the program. It will also settle training and manning issues and help to develop military tactics, techniques and procedures for operating the new weapon system.

Bottom line – the future looks bright for the continued use of Unmanned Aerial Vehicles for America's Security Operations. As an aviation pioneer and daring pilot, General James H. Doolittle would not be happy with UAVs, but as a MIT trained engineer and military risk taker he would understand their value to security operations.

What follows is a summary of the symposium's discussion and findings.

MORNING PANEL: OPERATIONAL USES OF UNMANNED AERIAL VEHICLES

Manned/Unmanned Air Vehicles in Wide Area Surveillance Operations.
Dr. Jonathan Schonfeld, Lincoln Laboratory

Dr. Schonfeld began his talk by establishing the distinction between reconnaissance and surveillance. Reconnaissance is intelligence provided on fixed installations at a low revisit rate whereas surveillance is intelligence provided on mobile and moving entities at a commensurately higher revisit rate. Surveillance is therefore the more difficult military problem, requiring greater processing power, better sensors and more efficient management of battlefield resources. Surveillance is essential to modern warfighting and is a highly complex challenge; surveillance success hinges on the effectiveness of automatic target recognition technology and the development of robust surveillance architectures.

Schonfeld described the history of Intelligence, Surveillance and Reconnaissance (ISR) using five components for elaboration (mission, platform, sensor, exploitation and complexity). Manned aircraft provided the early answers to military reconnaissance missions (in the 1950s through 70s). Satellites and Unmanned Aerial Vehicles (UAVs) will continue to expand the existing surveillance capabilities of military systems. He concluded his historical discussion by projecting to the year 2010, describing future wide area surveillance (WAS) platforms and sensors predicting that WAS will continue to be a critical military capability.

Wide Area Surveillance is a dynamic operation, especially with regards to the criticality of time and speed in surveillance operations. As the threat of war increases, so must the fidelity requirements of a sensor. In short, during peacetime periodic monitoring of countries and military bases is probably sufficient, but in war rapid tracking of individual force components is necessary.

In his discussion about surveillance drivers (user, timing, range, spacing, area and obscuration), Schonfeld described several manned platforms (Joint STARS, U2, Airborne Reconnaissance Low, Guardrail and the P3) as well as unmanned systems (Gnat, Predator, Global Hawk), explaining the role of each platform and its contribution to the surveillance picture. No one system is capable of "doing it all" because unique system limitations often conflict with surveillance requirements.

Schonfeld's last several slides spoke to current and future sensors and their capabilities, such as: Synthetic Aperture Radar (SAR), Automatic Target Recognition (ATR), Moving Target Indicators (MTI), identification of targets under foliage and Electronic Counter Measures (ECM). Many of these sensors are currently used (or planned to be used) on UAVs such as the USAF's Global Hawk and Predator. Modern technology has lowered the cost of high-performance sensing to the point that one can begin to think of it as a "commodity." Schonfeld said that this implies a copious flow of data, carrying within it the information that we need, which drives the need for ATR.

The most intriguing part of Schonfeld's briefing was his "Strawman Surveillance Architecture." His proposal had three layers, a deep look, a shallow look and a fire control level. Each of these layers had unique revisit rates and fidelity characteristics. Again, the closer to the earth (in reference to altitude of the sensor) the more timely and accurate the data from the surveillance platform. Schonfeld's prediction is that platform integration will be the next challenge to having a functional surveillance system that is responsive to military needs.

Acquisition of a Tactical UAV, A View from the Army Staff
Major Terry Pownall, UAV Integration Officer, Army Staff

According to Major Pownall the Army's UAV program is under the Intelligence proponency (or Battlefield Functional Area [BFA]), not the aviation branch, because of "operational need," and "pilot job security and funding." Army Intelligence recognized the battlefield need for a UAV and pursued development of a system when no other BFA picked up the mantle. The aviation branch shunned UAVs early on because they were seen as a resource competitor for manned aircraft, and a threat to pilots. Now the BFAs of Aviation, Signal and Close Combat are competing with Intelligence for future use of available UAVs.

Of concern to Major Pownall was the number of UAV failures in the recent past. He explained these failures as a result of too many players in the fielding process with too many requirements, along with the introduction of new, immature and untested technologies. However, with the dissolution of the Defense Airborne Reconnaissance Office (DARO) and the return of the UAV acquisition process to the services there will be a competitive environment for future UAV procurements. In addition, the system's requirements are solid, the capabilities of UAVs are unquestioned and current and projected advances in commercial technology will make it easier to buy off-the-shelf products, accelerating acquisition. Major Pownall believes that future Army UAVs will not duplicate the mistakes of the past.

Despite his optimism, Pownall recognizes that several problems still exist before the first Army unit receives its baseline of UAVs. The Army's progress could be impeded by "requirement creep," when a solid and simple system requirement gets complicated and expanded until it is no longer recognizable or achievable. There is also a threat of intra-service competition for control of the UAV program. The Army's Intelligence community will no longer be the sole source user and developer of UAVs. In fact, the Aviation branch is now vying for control. Pownall warns that although the Army is close to fielding a tactical UAV, these problems could still halt progress.

Pownall suggests heading off anticipated problems and turf conflicts by immediately getting a system out to the field. This would involve freezing all system requirements until the first UAV is fielded. Once the system is fielded, staff officers and users can expand upon baseline requirements.

A simple UAV can be fielded today but it must have the following minimal components:
1) Common ground station, data link and avionics packages
2) Common "plug and play" sensor payloads

If other UAVs must be purchased for special, unforeseen requirements, buy them commercially and remember that they must fit into the existing surveillance architecture.

Major Pownall's bottom line was straightforward – Field a brigade level, tactical UAV now. Get the system into the hands of soldiers. Keep the first UAV simple and recognize that the requirements will grow along with the Army's experience with the new weapon system.

USAF Predator Operations
Captain Dan Fritz, USAF, 412th Test Wing, Edwards AFB, CA

Captain Fritz began by explaining the functions of the 412th Test Wing, RA office. The Air Force Flight Test Center is working to become the military's center of expertise in UAV research, development and testing. The 412th TW/RA is chartered to "ensure that the USAF Flight Test Center's personnel, processes and facilities are compatible with all current and future UAV operations. To that end they work to create partnerships within the Department of Defense UAV community." In effect, this unit meshes the Air Force war fighter and program office requirements with contractor support.

One of the UAVs that has conducted flight test operations at the Flight Test Center is the Predator UAV, stationed in the Predator Reconnaissance Squadron at Nellis Air Force Base, Nevada. This squadron is comprised of eight air vehicles, three ground control stations and over 140 personnel. Predator provides the US military with a robust reconnaissance tool.

With a flight ceiling of 25,000 feet, an area loiter time of up to 24 hours, a payload capacity of 450 pounds and a range of 925 km, the Predator platform is a versatile military tool. As a combat system its components include; four air vehicles, one Ground Control Station, and a Trojan Spirit II satellite link. The entire package can be transported via five C-130 aircraft or two C-17 planes.

Although the air vehicles are the marquee item of the system, the ground control station (GCS) is where the real work happens. In the GCS system, operators fly the UAV and control its payload. A data exploitation and mission planning console, resident in the GCS, allows for mission planning and in-flight updates. As presently configured the Predator GCS takes up about half a football field. Although some tactical commanders may consider this to be too large a footprint, it must be remembered that this equipment will likely be found on or near an improved airfield, as the Predator UAV requires improved, hard-surface runways for takeoff and landing.

C-Band line-of-sight (LOS) communications and Ku-Band Satellite Communication (SATCOM) links connect Predator UAVs to their GCS. The C-Band affords transmission of real time, full-motion Electro-optical (EO) and infrared (IR) imagery of uncompressed images, at approximately 30 frames per second, out to a range of 100 nautical miles. There is no Synthetic Aperture Radar (SAR) capability in the C-Band mode. The Ku-Band SATCOM provides flicker EO/IR video, at approximately two frames per second of uncompressed images to anyone in the world with a SATCOM receiver. With Ku-Band SATCOM, transmission of SAR images is possible, albeit slow. Transmission of a single frame takes 4-5 minutes.

In theory, the combination of EO/IR/SAR sensors in the Predator system provides for a near all weather, day/night reconnaissance capability. The EO sensor operates a variable zoom lens, allowing for observation of targets through a 16mm to 160mm camera focal length. The payload provides NIIRS 5 and 6 images through the C-Band LOS links. The IR sensor offers three choices of camera focal length, 19mm, 70mm and 280mm. This payload provides NIIRS 4 at a 15-kilometer slant range. Finally, the SAR payload provides 600 to 1100 meter swath radar imagery out to a 11.2-kilometer slant range. In reality, Predator is constrained by weather. The Predator air vehicle cannot fly in icing, rain, freezing precipitation, or moderate to heavy air turbulence. Yet, under good flight conditions the system's sensors provide a great deal of valuable intelligence to military commanders at Corps level and below.

Of special interest to the conference attendees was Captain Fritz's discussion of the use of Predator during Operation Joint Endeavor. The region's Combined Air Operations Center (CAOC) exercised Tactical Control of the Predator asset, prioritizing requests for intelligence and issuing processed intelligence reports. This tasking and dissemination was accomplished via JDISS, very small aperture terminal (VSAT) and Stu-3 voice telephone. CAOC passed mission summaries, launch and recovery messages, real time video and annotated still imagery (EO/IR/SAR) to regional consumers. Additionally, imagery products were passed to the Joint Analysis Center in Molesworth, England. A combination of military (Trojan Spirit) and commercial (Intelsat 602 and Orion 1) satellite links provided a comprehensive dissemination conduit which made the Predator's product available to operators on the ground in Taszar, Hungary and to planners back in the Pentagon.

Captain Fritz addressed many of the operational concerns of flying a UAV in foreign airspace, side-by-side with manned aircraft. He described the staffing and coordination process that was necessary to come up with an operational agreement between the US forces and the Hungarian air traffic controllers. In effect, the agreement called for moving restricted air space around the Predator platform and establishing ingress and egress routes over Croatia and Restricted Operations Zones in Bosnian airspace.

Another initiative described by Captain Fritz was the Rapid Targeting System being studied and tested with Predator. This system links the Predator UAV images to the cockpit of a fighter aircraft via the Predator ground control station. Collected images are routed through the Predator GCS, up to a satellite and back down into the cockpits of USAF fighters. Called PROJECT STRIKE, this program holds great potential to reduce sensor to shoot time.

An interesting distinction between the USAF view of UAVs (in this case the Predator system) and the Army and USMC view is the emphasis on the rated pilot. The USAF, partly because it flies larger air vehicles at higher altitudes than the Army and USMC, is strongly committed to having aviators directly linked to the flight operations of the UAV. In most cases, the USAF treats a UAV like a manned aircraft (albeit at times reluctantly). This means those flight issues like pilot crew rest, crew duty day and aircraft scheduling are adhered to strictly. Accordingly, the weapon system is part of the regional Air Tasking Order (ATO) and controlled at a higher, more centralized level than one would find in the Army or USMC. The Army (and perhaps the USMC) would therefore argue that the Predator UAV system is a more formal and less responsive reconnaissance system.

The Ground Component Forces (Army and US Marines) do not require an aviator to be at the controls but do require that a pilot be connected with the mission planning and control of the UAV asset. This is a simple but important distinction that speaks to more than operational tactics, techniques and procedures. In part it reflects a difference in war fighting culture, where the Ground Component is more predisposed to decentralize a system's capability and rely on its noncommissioned officer corps than the Air Component.

Hunter Operations
Captain Dallas Keller, USA, 305th MI Battalion, Fort Huachuca, Arizona

Captain Keller divided his briefing into three parts; Hunter System overview, Hunter Operations at the National Training Center (NTC), and Hunter Operations in Kosovo. He began with a basic system description.

The Office of the Secretary of Defense (SecDef) discontinued the Hunter system in January of 1996, halting the production at seven Hunter systems. The SecDef did authorize the use of Hunter systems for testing, training and the development of Army UAV tactics, techniques and procedures (TTP). One and a half baseline Hunter system is maintained at the 305th Military Intelligence Battalion, Fort Huachuca, Arizona, where the UAVs are used primarily for training. Another system plus spares is found at the 15th Military Intelligence Battalion, Fort Hood, Texas. At Fort Hood TTPs are being developed through deployments to the NTC and the Joint Readiness Training Center (JRTC). Keller alluded to the fact that understanding the success and failures of the Hunter system provides keen insights into the future acquisition of UAVs.

A key difference between the Hunter system and the Predator UAV is the scope of the airframes. Hunter is smaller than Predator and less resource dependent. Hunter can takeoff and land on an unimproved dirt strip, whereas a hardened runway is required for Predator. In fact the Hunter system was designed to operate from an area no bigger or more refined than a soccer field. If necessary the system can be launched via rocket assisted boost, an operational capability that requires no runway or takeoff roll.

Hunter has a mission endurance of 12 hours and a maximum altitude of 16,000 feet mean sea level. Its normal operational altitude is between 5 and 8 thousand feet above ground level (AGL), with a cruise speed of 70 knots. A good Hunter crew is capable of launching an air vehicle within two hours after arrival on site.

Hunter current sensors include an Electro-Optical Video Camera with a 10mm to 140mm camera focal length. This camera can be operated in a manual or auto focus mode. Another Hunter sensor is the Forward Looking Infrared (FLIR) Sensor, with a 240mm maximum focal length. This sensor is capable of black-hot or white-hot polarity. Switching between these two FLIR modes is helpful during the analysis of imagery.

Optimal altitude for Hunter sensors is 5,000 feet above ground level (AGL). At this altitude the Electro-Optical Camera can cover approximately 2,100 square meters in a "narrow" search mode or over 610,000 square meters in a "wide" search mode.

Likewise, the FLIR, operating at 5,000 feet AGL, covers about 2,100 square meters in a narrow search mode or over 340,000 square meters in a wide search mode.

Like the Predator, Hunter uses ground control stations (GCS). Unlike Predator, two soldiers (non-officer types) work side by side in the GCS to control the Hunter air vehicle and its payload.[1] One soldier flies the UAV while the other operates the sensor package.

Adjacent to the GCS is a mission planning shelter where a senior non-commissioned officer performs detailed imagery exploitation and reporting. This shelter is the command and control element of the UAV operation. Finally, the Launch and Recovery Shelter (LRS) is the area that controls the takeoffs and landings of Hunter.

Hunter operates two data link antennas, the Ground Data Terminal (GDT) and the Launch and Recovery Terminal (LRT). The GDT is used to disseminate collected data from the UAV. The GDT links the operators in the ground control station and the UAV. The GDT allows for transmission and reception of telemetry and video from ranges of 125km and out to 200km through the use of a relay aircraft. The LRT provides telemetry transmission between the UAV and the GCS out to 50km. Like the name implies the LRT is used in the critical stages of launch and recovery of the UAV.

Another receiver of Hunter data is the Remote Video Terminal (RVT). Compatible with Joint STARS and Trojan Spirit, this terminal receives Hunter video at ranges out to 45km from the UAV. Data received by the RVT can be recorded on 8mm tape for playback and further analysis. The images

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[1] In contrast to the heavy commissioned officer involvement found in the Predator program, primarily non-commissioned officers run the Army Hunter program.

received in an RVT can also be transmitted through fiber optics cables to other RVTs or digital monitors on the battlefield. Despite its pronounced capabilities the RVT is quite small, about the size of a small footlocker, and easily transported by two soldiers.

Captain Keller described several operational sites for Hunter and explained their connectivity. The first was the Mission Planning Control Site (MPCS), an operational cell usually located within a quarter mile of a Tactical Operational Center (TOC). A MPCS would optimally contain two ground data terminals, two ground control stations and a mission planning shelter.

The second operational cell is the Forward Ground Control Site, which is used when UAVs are controlled from different locations. Captain Keller explained that the Forward Ground Control Site is the smallest configuration for Hunter UAV control, comprised of a single ground shelter, a GDT and one remote video terminal.

Finally, the sizeable Launch and Recovery Site was briefed. This is an operational cell found at the Hunter airstrip. This site requires at least fifty soldiers and approximately two dozen vehicles and/or shelters for maintenance, command and control and support functions.

With the basic system explained, Captain Keller talked about Hunter operations at the National Training Center. He said that field experience is continuously creating and modifying the operational doctrine for Army UAVs. Hunter operations at NTC incorporate the Forward Control Site (FCS) and a Launch and Recovery Site (LRS). Twelve soldiers, four vehicles, three trailers and two launch and recovery terminals are found forward with the FCS, while the LRS has nearly 80 soldiers and over 30 vehicles and ground support equipment on site. Located in an area known as Bicycle Lake, the LRS is a significant area of activity at NTC. It has to be – during a recent deployment, over a 14-day period, the Hunter UAV flew 30 missions and an average of 10 hours a day. During one 36-hour period, one air vehicle alone flew for over 27 hours.

At NTC the heavy UAV flight schedule is integrated into the NTC Airspace Management plan. For safety reasons, the Hunter UAV's launch and recovery site is placed within a Restricted Operating Zone (ROZ). This ROZ, an area 6 kilometers in diameter from the surface to 6,000 feet (MSL), allows for a safety buffer area between UAV operations and manned aircraft.

Once out of the ROZ the Hunter UAVs are assigned day and night "blanket altitudes" between 6,000 and

10,000 feet. In all cases the UAV area of operations is briefed to all pilots at NTC and in most cases the UAV zones are annotated on the aviator maps. Most significantly, Hunter UAVs are cleared for launch and recovery through the NTC air traffic controllers. These trained ATC personnel provide the ultimate eyes on safety check for UAV operations.

The deployment of the Hunter UAV to the NTC proved its worth as a flexible and responsive surveillance system. In a collection role it works directly for the S2, focusing on rapidly changing demands and taskings. In a targeting mode it can work for the Artillery Fire Support Officer, assisting with target acquisition, artillery adjustment and battlefield damage assessment. To be sure, the UAV's ability to dwell on one target makes it a valuable asset for the artillery commanders at NTC.

Additionally, Hunter can effectively support Army aviation assets. Already able to perform ingress and egress route reconnaissance, during past NTC deployments the UAV was used for experimentation and planning for communication relay and laser designation operations. Yet, the tactical UAV's capabilities are only starting to be understood. Its future role as an Electronic Intelligence collection and jamming platform and as an augmentation to a manned combat formation is just beginning to be imagined.

The briefing concluded with a discussion of Hunter operations in the Kosovo region. Although Captain Keller was extremely limited by classification considerations he was able to confirm that the system is flying in the Kosovo area and that it is disseminating its collected data to all theater consumers as well as military planners outside of the region.
Captain Keller views the Hunter UAV as a very reliable system for the U.S. Army, and views the acquisition decision to terminate the program as somewhat premature. Since 1994 it has flown over 9,000 hours with the last 1,000 hours being accident and incident free. Captain Keller believes that Hunter is a good system to use to help develop UAV tactics and operational procedures. He says that putting an operational UAV in the hands of soldiers is the best way to work out the growing pains associated with a new system's fielding.

LUNCHEON SPEAKER

Army UAVs and the Future of Aerial Common Sensor Concept
Colonel William Knarr, USA, Army Training and Doctrine Command (TRADOC) System Manager for the Unmanned Aerial Vehicle and Aerial Common Sensor, Fort Huachuca, Arizona

On 16 October 1998, Major General Charles Thomas, the TRADOC Chief of Staff, approved the establishment of an integrated concept team (ICT) for Unmanned Aerial Vehicles (UAVs). This team will coordinate the development of UAV missions and payloads. MG Thomas and I believe that to be successful, the ICT must capitalize on existing sensor technologies and the growing synergy within the UAV community.

Within the past weeks, the Office of the Secretary of Defense, through the Defense Acquisition Board, decided to stop the Outrider Program, determining that this system did not meet the Army's Close Range UAV requirements. As a consequence of this decision the Army's requirements for a CR-UAV remain unfilled. Accordingly a fly off will occur in the late summer, early fall time frame in an attempt to select a CR-UAV system. Now that we have aligned our requirements within the Army community with the required Army staff elements, I predict the fielding of a tactical UAV by the year 2001.

This fielding will occur as the Army continues to develop experience with UAV tactics, techniques and procedures through its use of the Hunter system. We are having great success with this UAV and although the acquisition of future Hunter platforms has been "frozen" at 7 systems, Hunter plays an extremely valuable role in training and crisis deployment.

In December of 1998 I presented a decision brief to General Dennis Reimer, the Army Chief of Staff. I looked to the Chief to decide which Army training center should be selected as the site for the Hunter tactical UAV. After much debate over the merits of the National Training Center, Fort Irwin, California versus the Joint Readiness Training Center (JRTC), Fort Polk, Louisiana, the decision was made to put a Hunter baseline system at the JRTC.

At the JRTC the system will be used to help train the Army on UAV capabilities and limitations. JRTC supports training in low to mid-intensity conflict scenarios. It further provides a good alternate to the terrain common to NTC exercises. In short, deployment of Hunters to JRTC will help develop operational procedures for the use of UAVs in support of light forces. Finally, it gives UAV operators another choice for assignment beyond Fort Huachuca, Arizona and Fort Hood, Texas.

As the Army continues to expand its use of UAVs we are concurrently making significant improvements to our manned intelligence aircraft. An aggressive transition is now underway to replace the old, multiple platform, single intelligence node systems such as the old OV-1D Mohawk (which provided imager intelligence) and the old Guardrail V System (communication intelligence) with multiple modular sensors found on a single platform. This future system will integrate with the developing information dominance sensors and platforms of Force XXI and the Army After Next.

The airborne system that is leading this transition is the Airborne Reconnaissance Low (ARL). ARL is found on a modified DeHavilland DHC–7, now equipped with Electro-optical imaging sensors, and moving target indicator and synthetic aperture radars. By the end of fiscal year 2000 these aircraft will have additional optical sensors, signal intelligence pods and a Tactical Common Data-link (TCDL). Most importantly, the sensors on ARL will augment and complement one another, making them truly multi-functional and providing the Army with its first truly integrated airborne intelligence asset.

The work on ARL is progressing in concert with new improvements in the Army Guardrail Common Sensor (GRCS) system. GRCS is nearing the stage in its development where its advanced signal targeting capabilities will be able to be processed onboard the aircraft and beamed directly through a satellite relay to any intelligence consumer in the world. This system called the Direct Aircraft to Satellite Relay (DASR) will be fielded in the 3rd quarter of FY00 and will eliminate the need for ground processing or relays. Combining the DASR capability with a down-sized processing facility mounted on the back of a high mobility multi-purpose wheeled vehicle (HMMWV) will yield an "Army After Next" improvement over the current significant capabilities of GRCS.

The bottom line on these merging developments is that the future of Army airborne intelligence will be realized by 2010 in a system called Aerial Common Sensor (ACS). This system will be a concept tied more to an architecture and multi-sensor capability than to a specific aircraft or sensor platform. In some cases ACS will be manned while in other scenarios it may be an exclusive UAV show, while in a third scenario a mix of manned and unmanned sensors may be what is required to satisfy the mission needs of the battlefield commander. In any regard, the current path, which harnesses advancing technology while pushing where possible on the closure points will yield an airborne reconnaissance and surveillance platform, ACS, that will be the finest in U.S. military.[2]

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[2] The original presentation of Colonel Knarr's ideas can be read in *the Military Intelligence Professional Bulletin*, January-March 1999, PB 34-00-1, Pg. 51-52.

AFTERNOON PANEL: DEVELOPMENT OF SERVICE OPERATIONAL REQUIREMENTS FOR UNMANNED AERIAL VEHICLES

USMC UAV Requirements
Captain David Gerlach, USMC, USMC Systems Command, Quantico, VA

Captain Gerlach began his brief by describing the USMC requirement process. He explained the progression and relationship between the Fleet Operational Needs Statement, the Mission Needs Statement (MNS) and the Operational Requirements Document. Different agencies contribute to the development, refinement and processing of these documents.

Captain Gerlach gave more specifics as he talked about the operational requirements for the Close Range, Vertical Takeoff and Landing (VTOL) and Small Unit UAVs. Each of these UAV systems provided amplification of the procedures that must be worked in order to push a concept through to completion. For example the Small Unit UAV is a system being developed from the drafting of a Fleet Operational Needs Statement (FONS). The FONS states that the Small Unit UAV should have a range of approximately 10kms and an endurance of 30 minutes or less. It must have an Electro-optical capability and be man-portable and hand-launched. Captain Gerlach displayed a matrix of requirements that has developed for the Small Unit UAV and stated that these requirements will be examined during a Dragon Warrior "Warfighting Experiment." He explained that Headquarters Marine Corps, Command, Control, Communications and Computers and Intelligence leads the service's effort to develop the MNS for the Small Unit UAV.

As Captain Gerlach explained the USMC UAV requirements it became apparent to Army attendees that the service specific requirements of the USMC cannot be met by building a "universal" UAV. This leaves the Marine Corps with a few options. They can demand the creation of a service unique UAV or go back and modify their service requirements, if the Army will not modify its requirements. Gerlach led a discussion and provided examples about the implications of this acquisition impasse.

The first example was the USMC decision in June of 1998 that the Outrider UAV would not meet the Corps' needs. Secondly, the Corps knew that a VTOL UAV, a solution favored by the Navy, would not satisfy the desires of small unit leaders for real-time imagery. Accordingly, after many debates and bureaucratic staffing, the Joint Requirements Oversight Council (JROC) approved the development of two UAVs for the USN/USMC. While these systems are developed the USMC is directed to sustain the Pioneer as a transitional system.

After providing insights on the requirement process, Captain Gerlach turned his attention to describing the Naval UAV Executive Steering Group's plan for UAV acquisition.

This plan's main points are to:

1) Sustain Pioneer until the fielding of a VTOL UAV system (FY00-05).

2) Sustain the VTOL system and field a Medium Altitude UAV and Small Unit UAVs (FY06-14).

3) Field Micro and Combat UAVs (FY15-25)

In order for the plan to work, each of the UAVs that provide critical capabilities to the Naval UAV Executive Steering Group's grand UAV architecture must be fielded and functional. Within this understanding, the VTOL UAV seems to be the most solid program. The VTOL Operational Requirements Document (ORD) is complete and was approved in December 1998. According to the ORD, the VTOL must:

1) Be able to carry a 200lb payload at a 4,000 feet density altitude

2) Provide automatic launch & recovery from ships at sea

3) Operate using JP5 and JP8 (aircraft fuels)

In July of 1999 the USS Boone will host the testing of the VTOL Bombardier during a 21-day period. A competing VTOL Bell system will be tested in February of 2000.

When ready the VTOL UAV will deploy with a Navy Battle Group in support of forward operations. Likewise, the system will deploy with Marines in support of Operational Maneuver from the Sea and Marine Expeditionary Units. In total 23 systems (with 4 UAVs per system) will be procured. The Navy will receive 12 systems and the Marine Corps 11.

The Navy's progress with the Medium Altitude Endurance (MAE) UAV is not as tangible as their work with the VTOL program. Currently the Navy must depend upon the USAF Predator UAV as its MAE system. This of course is a workable solution and indeed there is talk that the Navy will control Predators from a ship-based Tactical Control Station (TCS).

However there are two problems with this concept. The first is the limited number of Predator UAVs. There simply are not enough air vehicles to meet USAF, Army and Navy requirements. The second problem is that the USAF operates Predator with a validated Concept of Operations (CONOP). This CONOP does NOT allow other services to control Predator. Consequently, if the Navy seeks to have a viable MAE program it appears it will have to develop its own system, independent of the USAF program, or work an agreement for the Air Force to provide systems and operators in support of Naval missions.

The Navy Steering Group initiative for International Technology was covered during the last quarter of Captain Gerlach's briefing. The first item addressed was the objective to evolve the communication antennas for UAVs. The goal is to move from today's C-Band, line-of-sight antenna, where each aircraft requires a separate antenna, to a state where one antenna simultaneously supports multiple UAVs. This technology is projected to be available by 2010. Secondly, there is a stated need to replace all analog data-links with digital systems. This capability is achievable within the next 10 years.

Captain Gerlach concluded his briefing with slides depicting UAV experimentation. Of critical importance to the Navy is the use of simulation and technology review boards to establish savings and training priorities for Navy UAVs. From a Navy perspective there has been a wide operational variation during the last several deployments of the service's UAVs. The prime reason for these differences is the unfamiliarity of the Naval commanders with the capabilities and limitations of the UAV system. Accordingly, the Navy Steering Group believes that simulations will afford fleet commanders with a free opportunity to train and familiarize themselves with UAVs prior to use in a real world deployment.

Major Gregory Dragoo, USAF, 412th Test Wing, Edwards AFB, CA
The Joint Nature of UAV Testing

The mission of the USAF Flight Test Center is to support the development, test and evaluation of manned and unmanned air vehicles. Located at Edwards Air Force Base, California, it has over 68 miles of lakebed runways, over 5 miles of which are paved. Most significantly, they have over 20,000 square miles of instrumented ranges in which to conduct testing.

In addition to USAF UAV programs the UAV facility at Edwards AFB tests and flies other services' UAVs. The Navy, in conjunction with NASA, has tested the LoFLYTE and the Mach 5 Waverider which both have a neural network incorporated into their design. With a neural network, the system, not the pilot, gives flight commands to the air vehicle. Neural networks learn from experience, can generalize from their data set, are fault tolerant and can exploit parallel systems for rapid data processing. This system is most effective during abnormal flight, because the neural network can adjust to changing flight conditions faster than a human pilot, enhancing both flight safety and system survivability.[3]

Also tested at the base was the BQM-74, the Navy's low-cost subsonic aerial target that simulates low-altitude aircraft and missiles and the Dragon UAV, an air vehicle developed by Matra Bae Dynamics. The Dragon, a small UAV capable of carrying a 100-pound payload out to a range of 35kms, is a system that is recoverable by parachute.

The testing that occurs at the ranges of Edwards is consistent and fully supports the service's concept of UAVs. This concept can be viewed in three phases: near-term, mid-term and long-term.

- Phase I – (2000-2005) UAVs continue to focus upon intelligence, surveillance and reconnaissance.
- Phase II – (2005-2015) UAVs expand into the job of communications relay and suppression of enemy air defenses.
- Phase III – (2015 and beyond) the concept is still in development but includes combat air vehicles.

These projected phases of Air Force UAV developments involve the fielding of three prominent platform categories; the Medium Altitude Endurance (MAE) UAV, the High Altitude Endurance (HAE) UAV and the Uninhabited Combat Air Vehicle (UCAV).

The Air Force MAE UAV is a solid program. The system flying today is called Predator. Originally developed from a Department of Defense acquisition initiative called the Advanced Concept Technology Demonstration (ACTD), Predator moved from engineering blueprints to fielding in less than two years. It is one of the true success stories of the ACTD concept.

By an Air Force program description Predator is "a Theater Level asset apportioned and allocated according to theater and Joint Force Commander requirements."[4] It is the current workhorse of the USAF's UAV systems. Currently, Predator augments manned Reconnaissance, Surveillance and Target Acquisition (RSTA) platforms.

The other two categories of UAV systems (HAE and UCAV) are still in development. The Air Force

[3] Information on UAV neural network systems taken from the NASA LoFlyte Web Page, http://oea.larc.nasa.gov/PAIS/LoFlyte.html

believes that HAE UAVs hold great promise as part of their Global Reach strategy. HAEs will not only augment but may eventually replace manned RSTA aircraft.

One HAE UAV, the Global Hawk, first flew in February of 1998.[5] To date, it has flown over 18 flights. Although an accident destroyed the program's air vehicle #2 in March of 1999, the Global Hawk program still holds great promise for military reconnaissance.

As an HAE UAV, Global Hawk has an operational altitude of 65,000 feet, a true air speed approaching 400 knots and an endurance of over 24 hours. It can carry its sensor package of SAR and MTI radars or IR and EO cameras out to a mission range of over 3000 miles. Optimally, it can provide a 40,000 square nautical mile area search or coverage of over 1900 spot images during its time on station. A detailed sensor capability is provided in the table below.

Synthetic Aperture Radar (SAR)	20 to 200 km range Strip map at 1m resolution Spotlight at .3m resolution
Moving Target Indicator (MTI)	4 km minimum detectable velocity
EO	7 inch resolution Wide Area Search Mode – 138,000 km/day Spotlight Mode – 1900 Spots/day at a 2 km x 2 km per "spot"
Infra-red	20 inch resolution Same as EO

The Air Force is concerned with survivability of the expensive Global Hawk system and has taken steps to ensure the UAV's safety. The system's survivability is enhanced by its flight profile; flying at high altitudes minimizes Surface to Air Missile Exposure. The current plan to increase survivability is to use theater assets, such as AWACS, to help detect threats before they become a danger. Mission planning during the early stages of flight planning will also be an important step in threat avoidance. Additionally, Global Hawk incorporates Electronic Counter Measures, has an on-board jammer, a threat-warning

[4] Predator was described in detail during an earlier panel review of Captain Dan Fritz's briefing.
[5] A second HAE platform, the DarkStar program, was cancelled in January of 1999 after it was determined that the cost associated with developing a stealth, deep penetration behind enemy lines UAV, was not warranted.

receiver, and is capable of towing a decoy behind the UAV.

Future initiatives with Global Hawk include work by the Defense Advanced Research Projects Agency (DARPA) to develop scalable airborne payloads to extend and expand theater communications. The goal is to have a technology demonstration of this capability by Fiscal Year (FY) 2002.

In line with other USAF systems, Global Hawk must be staged off of an operational airfield. To assist with an automated launch and recovery system, it uses a differential Global Positioning System (GPS), controlled from a Mission Control Element (MCE). The MCE is capable of flying and managing up to three air vehicles and can disseminate imagery from the HAE UAV to consumers.

The final category of UAV, the UCAV, is an area of new development and aggressive contractor work. Boeing has been selected as the contractor to develop combat UAV prototypes. Like HAE, UCAV may augment manned fighter systems in the future. Currently, DARPA is funding an ACTD to examine the feasibility of uninhabited fighter aircraft. The goal is to have a final design, test and concept demonstration conducted by FY05. This demonstration will be conducted by NASA Dryden.

The Air Force Flight Test Center has identified several issues that must be examined and resolved prior to future expansion of UAV use, including:

- U.S. airspace regulations and international flight rules - UAVs must be in compliance in order for their operations to be seamlessly integrated into flight routes and commercial airspace.
- Technology De-confliction – Power requirements and frequencies must be de-conflicted between UAVs and manned aircraft, radio stations and satellite signals. It does no good to operate UAVs if their presence knocks out other critical combat or commercial communication nodes.
- Fighter Pilot Ethos – Can today's military warfighters accept being replaced by UAVs in future military operations? Will the systems augment or replace the current manned platforms? Can the platforms co-exist? Are there new missions for the humanless air vehicles?

Major Dragoo concluded that UAVs hold great potential for future operations and that through experimentation the true value of these systems will be understood and exploited.

Acquisition of Army UAVs
Lieutenant Colonel Edward Gozdur, USA, Tactical UAV Program Manager Office

Organizationally, the Joint Tactical UAV (JTUAV) program falls under the management of the Program Executive Office, Intelligence Electronic Warfare and Systems Office. Four divisions make up the JTUAV program office, all focused on the task of fielding a UAV to the Army's soldiers.

The JTUAV office utilizes an open architecture approach to developing the Tactical UAV (TUAV), allowing for the integration of available technology where possible. It also synchronizes the energies of existing agencies that deal with UAV operations (such as the Joint UAV Training Center at Fort Huachuca and the Army Materiel Command at Redstone Arsenal). These agencies are often consulted by the JTUAV office before major acquisition milestone decisions.

Currently the JTUAV project office is tasked to manage the Outrider and Hunter UAVs and the future tactical UAV system. As part of this responsibility the office must smoothly incorporate the many divergent elements of hardware and software development. Some of the things they worry about are the integration of avionics, communications and payloads, embedded training, flight data recorders, antennas and common data links. The task is daunting and accomplished by a handful of JTUAV staff officers.

One good example of the management success of the JTUAV office is the Hunter program. Under the direction of Colonel Mike Howell, LTC Gozdur and their associates, Hunter has made great strides since 1996. It has logged over 1700 flights and over 5300 flight hours and in many ways is a different system than the one originally configured.

Primarily used for training and experimentation, Hunter has shown distinction during 4 NTC rotations, exceeding its baseline requirements during those deployments to Fort Irwin. Due to Hunter's demonstrated capabilities at NTC, the system is in great demand. On 29 March 1999 it deployed to Operation Allied Force to support operations in Kosovo. That same month, another baseline of Hunter was assigned to the Joint Readiness Training Center (JRTC) in Fort Polk, Louisiana.

Hunter's growing pains have paved the way for future tactical UAV operations. EO, IR, SAR and communication payloads have been tested and are in use today on the Hunter system. Laser designators and lethal weapon dispensing systems will be employed on those systems that follow Hunter.

The OUTRIDER UAV was to be one of those UAVs that replaced Hunter. As part of an ACTD, OUTRIDER was to show that it was capable of supporting the RSTA requirements of the Army Brigade as well as equivalent USMC and Navy commanders. The system had a publicized altitude of 13,000 feet and an endurance of 4 hours. It carried an EO/IR payload and was capable of auto takeoff and landing. Unfortunately, because of flight failures and an inability to meet established milestones the ACTD was closed out by DoD. However, the ACTD did:

- Introduce GPS navigation and the auto-launch and recovery to TUAV
- Refine the Army brigade commanders' TUAV requirements
- Disprove the notion that one UAV can perform the job for all services

With the termination of the OUTRIDER ACTD an Acquisition Decision Memorandum was issued on 12 March 1999 approving the Army's approach to fielding a TUAV. In effect, it gave the Army a green light to pursue its own TUAV requirements independent of the USMC and Navy.

The Army's current strategy for the TUAV is simple – to field a capable UAV to the ground maneuver brigade commander as soon as possible. This UAV will be a basic air vehicle without a lot of superfluous hardware hung on board. Some of the candidates for the Tactical UAV include the Bombardier, the Aerial Robotics Freewing 100, the Sentry, and the Shadow 200. These systems range from a maximum takeoff weight of 250lbs (Sentry) to 750lbs (Bombardier) and from an endurance of 4 hours (Freewing) to 6.5 hours (Shadow).

The ambitious schedule for the TUAV includes three phases:

- Phase 1 (June 99) Downselect
- Phase 2 (July to September 99) Fly Off
- Phase 3 (September 99) Low Rate Initial Production Award

What is unique about the going-in Army strategy for the TUAV is the clear prioritization of system requirements. The most important requirements (must be capable of running with Military Fuel or MOGAS, must carry an EO/IR payload) must be met first. There is no compromise on these baseline requirements. From this start point, additional capabilities are added to the UAV to increase its value as the prime TUAV candidate. These "less important" system characteristics are grouped into three groups, A through C, with the A group being the most significant. Examples of A group requirements are: range and endurance, transportability and target location error. Examples of C group requirements are information security, electrical power and frequency bandwidths.

LTC Gozdur's briefing gave me the impression that the Army is finally close to fielding a new UAV to the ground force. The system requirements are solid and achievable by bidding contractor and the Army leadership and Congress support the acquisition of unmanned systems.

Development of Army UAV Requirements
Colonel William Knarr, USA, Training and Doctrine Command System Manager for UAVs, Fort Huachuca, Arizona

Colonel Knarr began his talk with a description of the Army Family of UAVs, which includes theater and strategic UAVs (Global Hawk and Predator), interim UAVs used for training and crisis deployments (Hunter), and UAV systems that have yet to be developed (a UAV for the Army division and corps, a UAV for the brigade and below, and micro UAVs). He explained how the operational requirements for these systems were developed and described the current fielding status for each system.

Placing the present into a historical context, Colonel Knarr summarized the Army's past requirements for UAVs. In 1988 the Army had a three tier level requirement. The Close-Range (CR) UAV would be developed to support the brigade commander and below, with a range out to 50kms and an on-station time of around three hours. The Short-Range (SR) UAV would support the division and corps and cover out to 300kms, with a capability to loiter in a region for about ten hours. Finally, the Endurance (E-UAV) was seen as providing coverage for echelons above corps, out to a range beyond 650kms. Mission duration for E-UAV would be in excess of 24 hours.

Under the old UAV strategy Hunter was tasked as the SR system. Unfortunately, the Secretary of Defense stopped the procurement of additional Hunter systems in December of 1996, freezing procurement at seven baseline systems, which prevented Hunter from fulfilling its role as a Short Range UAV. Although there were many reasons for the decision, the primary factors were:

1) Poor accident record (5 crashes in June through August of 1995)
2) Poor maintenance reliability (availability of manuals and spare parts)
3) Large airlift requirements (5 x C5s required to transport one system)

This decision may have been premature, considering the success that Hunter has recently experienced at NTC and its deployments in Bosnia and Kosovo. However, at the time the senior DoD leadership made what it deemed was the right call by terminating the program.

Although DoD stopped the procurement of additional systems it allowed for the continued use of available Hunter UAVs for the purpose of testing and experimentation. This decision has proven to be a fortuitous turn of events for the Army because many lessons have been learned from Hunter. Its workload has been impressive. One system is now at the JRTC in Fort Polk where it supports Army Light Force rotations through the training center. Other Hunters have deployed to two NTC rotations (NTC 96-10 and 97-06). Additionally, the system has demonstrated its ability to provide UHF/VHF communication and data relay and an efficacy to work as a laser designator (9 for 9 kills with Hellfire and 3 for 3 kills with Paveway). Hunter has also served as a payload platform for COMINT and ELINT collectors and jammers and has worked with the Navy during suppression of enemy air defense exercises.

With the end of Hunter, the Army's SR-UAV system, vanished coverage of the 50-300km area of the battlefield. However, the SR requirement still remained and had to be satisfied by one of three options: relaxing of the initial SR requirements, procurement of a new UAV, or covering the Short Range zone with an existing UAV.

The Joint Requirements Oversight Council (JROC) picked the latter option, determining that the Air Force Predator UAV could satisfy the Army SR requirement. The JROC solution was to adjust the USAF Predator UAV coverage down to cover the 200-650kms area of the battlefield while extending the CR UAV's range out to 200kms.

In theory, this solution seemed possible. However, this operational compromise may be more optimistic than realistic. In an exercise assessment during Ulchi Focus Lens in South Korea (August 1997) it was determined that there were not enough Predators to support both the USAF and ground component commanders' requirements. Additionally, tasking of the Predator system was too cumbersome and dependent upon dedicated communications.

Although the Army understood that some operational limitations (tasking and communications) could be improved upon or fixed, it was skeptical that there would ever be enough Predator air vehicles available to support simultaneous air and ground campaigns. In any event, the problem of the SR coverage still remains unresolved.

In contrast to the SR system, the Army's position on the Close Range (CR), now called the brigade commander's UAV or tactical UAV (TUAV), is solid. The necessary Army requirement documents have been approved and are in place to support the development of a TUAV. Additionally, the Joint

Requirements Oversight Council (JROC), the organization that determines such issues, decided in favor of the Army pursuing a single UAV to meet its unique service requirements.

The current plan calls for a simple UAV that satisfies the situational awareness needs of ground component commanders. A TUAV will provide "eyes-on" coverage of the ground to the immediate front of the brigade. It will validate predictions, developed through operational templating, about the location of the enemy and support maneuver and operational fires.

A TUAV will integrate with the high-speed electronic information flow of its surrounding battlefield systems. Not only a commander's organic system, the TUAV will also link to other command, control, communications, computers and intelligence (C4I) nodes in the brigade area of operations (like the Ground Control Stations and Airborne Command Stations). In short, the tactical UAV will be part of a reconnaissance, surveillance and target acquisition (RSTA) triad between itself, scouts, and electronic analysis centers. If the TUAV comes close to realizing its promised potential it will help to reduce the combat power required in a heavy division by increasing the accuracy and speed of available RSTA systems.

The promise is that a TUAV will happen before 2002. Once fielded, the ground component commander can expect to realize the following capabilities:

Launch and Recovery	Rocket assisted takeoff from soccer field. Auto launch and recovery as the objective goal
Fuel	Heavy fuel as the objective goal
Compatibility	Yes with USAF and Army Systems
Payload	Day/night passive imagery
Range endurance	50 kms 4 hours
Targeting Accuracy	80 meters CEP with 20 meters as the objective goal
OPTEMPO	12 hrs in 24 with a surge capacity of 24 hrs in a 72 hr period
Transportability	System to fit into 4 HMMWV and 2 trailers/2 x C-130 loads

In addition to the TUAV, the Army requires the development and fielding of a micro UAV. These systems, expected in the field between 2010 and 2025, will support small task forces and special operations units. Although it appears very futuristic on paper, DARPA and those contractors in support of the requirements say that the technology necessary for micro UAVs is available now or attainable in a few years. What is needed is a clear understanding of what the services want. Accordingly, requirements for Micro UAVs are being carefully formulated to ensure that the needs of the Army and the Special Operations Command are met. The current requirements include:

Range	10 km
Data Transmission	Near Real Time
Dissemination	Downlinked Imagery, Received on a Walkman size device
Cost	Low (below $50k each), Objective is to be expendable and/or reusable
Ease of Operation	Simple
Sensors	EO/IR and a communications relay
Operating Capabilities	In winds up to 20 knots, ability to hover, hand launched, alight/rest/relaunch

The final Army concern in the issue of UAV battlefield coverage is access to High Altitude Endurance (HAE) systems. Accepting the fact that it will never have its own HAE UAVs, the Army supports Air Force ownership and operational control of HAEs. What is required is access to the sensors and their product and for a say in the payload development of these UAVs. This requirement will be satisfied if future HAE UAVs are connected to the Army EAC and Corps processors, such as ETRAC and GRCS.

With the fielding of a micro UAV, the presence of a TUAV and access to the Air Force MAE (Predator) and HAE systems, the Army's predominant war time UAV surveillance requirements should be satisfied. What remains is an efficient way to coordinate the control and product of these divergent air vehicles. The Tactical Control System (TCS) provides this solution.

The TCS is the future focal point for UAV data and dissemination. The concept is for TCS to merge "system specific" ground control stations and ground data terminals of current UAVs into one station. Future UAVs will be compatible with the TCS from the start. Most significantly, the TCS will allow for an interface with the information feeds from other intelligence and battlefield systems (JSTARS, GUARDRAIL, ASAS, CARS, ETRAC). The assumption is that a TCS will cost less than developing and maintaining individual ground control stations for each UAV. The full operational capability of the TCS is projected for the winter of 2001.

Colonel Knarr's detailed briefing concluded with an explanation of his current initiatives with the Air Force Battle Lab and the Armor, Infantry, Aviation, Artillery and Special Operation Forces branches. He also talked about his association with the Navy's vertical takeoff and landing UAV. Colonel Knarr stressed the need to share in the synergy created by each service without losing sight of the Army requirements. His involvement as the TSM-UAV guarantees that Army's battlefield surveillance requirements are secure.

DINNER SPEAKER

Lieutenant General William H. Campbell
Director of Information Systems for Command, Control, Communications, and Computers (DISC4) and the Army Chief Information Officer

LTG Campbell has been associated with UAVs for over half of his 36 years of Army service. His engaging dinner speech highlighted the need for the Army to remain committed to the acquisition of an unmanned aerial vehicle for tactical commanders.

In regard to UAVs, Campbell supports the quick acquisition of a simple system. While acknowledging the many reasons why unmanned aerial vehicles are not yet flying, he believes that it is past time for the Army to have a tactical UAV in support of ground troops.

To illustrate his perspective on UAV acquisition, the General told two stories, each containing lessons for UAV procurement. The first story was about the Army's development of the Airborne Reconnaissance Low (ARL) capability.

In 1989, General Maxwell Thurman, the Commander in Chief of the United States Southern Command, contacted LTG Campbell, then serving as the Program Executive Office for Intelligence Electronic Warfare (PEO/IEW) systems. This contact occurred several months prior to President George Bush's military action to dispose of the Panamanian dictator, Manuel Noriega. Thurman told Campbell that he had a matter of days to write a requirements document and then only a few months to deliver a multi-purpose surveillance aircraft to the forces in SOUTHCOM. The urgency and directness of Thurman's order was somewhat disquieting but when General Thurman talked, people listened. The end result of the General Thurman tasking was that the Army received a multi-mode, state-of-the-art intelligence platform in just over a six-month period.

ARL was not a joint program. It did not go through a formal Army acquisition cycle. It was a program developed from a CINC's mission needs statement and fielded with a substantial amount of program risk. Yet ARL succeeded and is today an important platform for Army reconnaissance and surveillance.

The second story was about the fielding and testing of the Aquila UAV. In the 80's, Aquila was to answer the Army's requirement for a tactical UAV. Many officers thought that the triangular shaped UAV could satisfy the needs of the ground component commander. Unfortunately the system was not perfect and it fell short of the exact parameters of the testing community. Without their endorsement the program was killed.

LTG Campbell's stories provide the following insights:

- Although "Jointness" is good, it is sometimes okay to develop and push for a service unique system.
- Taking a risk is often necessary with new or innovative weapons.
- Don't expect perfection in testing.
- It helps to have a "heavyweight" advocate push a system.

Lieutenant General William Campbell, USA is the Director of Information Systems for Command, Control, Communications and Computers and the Army Chief Information Officer. General Campbell has 36 years experience and training in Information Technology, program management, and military leadership.

Major Gregory Dragoo, USAF was commissioned in 1983. He has served in a wide variety of flight and staff assignments. He was selected as the Director of the 412th Test Wing UAV Office in 1999. In this capacity he serves as the focal point for the Air Force Flight Test Center's developing UAV requirements and policy.

Captain Dan Fritz brought USAF Predator program insights to the conference. Serving as the commander of the 11th Expeditionary Reconnaissance Squadron, Dan Fritz deployed the Predator UAV to Taszar Airbase in Hungary in October - December of 1997. While in Taszar his squadron conducted daily reconnaissance flights over the former Yugoslavia Republic, specifically in the Bosnia-Herzegovina area. Captains Fritz's briefing supplied a joint flavor to the morning's panel discussion.

Captain David Gerlach, the Marine Corps System Command's representative to the Navy's UAV Executive Steering Committee, enlisted in the Marine Corps in 1984. A 1989 graduate of the University of Florida, Captain Gerlach is an aviator who has flown and supported USMC operations in Bosnia and Somalia. His talk on the development of USMC UAV Requirements provided the afternoon panel discussion with a ground component perspective.

Lieutenant Colonel Edward Godzur has a wealth of experience in the Army Acquisition field. This includes work with the Hellfire Missile System and Cruise Missiles. He now works as the Assistant Project Manager for UAV integration and applications at the Joint Tactical Project Office in Huntsville, Alabama.

Captain Dallas Keller, USA has been the operations officer at the 305h Military Intelligence Battalion, Fort Huachuca, Arizona for over a year. Prior to this assignment he performed similar duties with the 15th Military Intelligence Battalion, Fort Hood, Texas. While in the 15th he deployed the Hunter UAV system to the National Training Center (NTC).

Colonel William Knarr has served the Army for over 26 years. He has commanded at every level from platoon through a brigade equivalent unit. In addition to his military education he holds a Ph.D. in Education. His address to the conference explained how the Army will integrate UAVs into future airborne intelligence operations.

Major Terry Pownall is a systems coordinator on the Army Staff. His office, the Assistant Secretary of the Army for Acquisition, Logistics and Technology prioritizes and funds new weapon systems for the Army. Major Pownall was invited to speak at the Doolittle Conference because he is considered a subject matter expert on the Army's tactical UAV program.

Colonel Leonard Samborowski, the MIT Security Studies Program's 1998-1999 U.S. Army Fellow, is an intelligence officer specializing in airborne reconnaissance and surveillance. He has commanded both a military intelligence aviation battalion and a recruiting battalion. Colonel Samborowski has aLegion of Merit for his work on unmanned aerial vehicles.

Dr. Jonathan F. Schonfeld is the Assistant Head of the Surveillance and Control Division of Lincoln Laboratory. A notable scholar he served in the Office of the Secretary of the Air Force (1992-1995), where he established innovative improvements in microelectronics and radar-based wide-area surveillance. Dr. Schonfeld's comments provided an opening technology perspective to the issue of unmanned surveillance.